Biological Evaluation of Ash Trees
At
Valley Forge National Park and Hopewell Furnace Historic Site

Prepared By:

Karen Felton
Entomologist

USDA Forest Service
Northeastern Area State and Private Forestry
Forest Health Protection
180 Canfield Street
Morgantown, WV 26505

December 2015

TABLE OF CONTENTS

Photos 2

Abstract 3

Purpose and Need 3

Species Evaluation/Background 3

Project Location/Description 5

Project Objectives 8

Project Methods 8

Results 9

Discussion 11

Management Options 12

No Action Option 12

Intervention Options 12

Chemical Insecticide Option 12

Biological Control Option 12

Management Alternatives 13

Alternatives 13

Recommendations 13

References 14

Photos:

3 Photos of Valley Forge NP and Hopewell Furnace NHS *by Karen Felton, USDA FS, Morgantown, WV*

EAB - 5449376 *by Debbie Miller, USDA Forest Service, Bugwood.org*

EAB - UGA1439005 *by Taylor Scarr, Ontario Ministry of Natural Resources, Bugwood.org*

Abstract

In late October 2015, Forest Health Protection personnel from the Forest Service, U.S. Department of Agriculture, Northeastern Area, State and Private Forestry Field Office in Morgantown, WV, visited Valley Forge National Historical Park and Hopewell Furnace National Historic Site. The purpose of the visit was to see if emerald ash borer *Agrilus planipennis* Fairmaire, was present; discuss the process for assessing the health of the ash trees; and determine the need for management activities at the Parks. No EAB have been detected at the time of the report.

Emerald ash borer has been detected in Montgomery County, about 16 miles from Valley Forge National Historical Park, and in Berks County, about 25 miles from Hopewell Furnace National Historic Site. It is recommended that a comprehensive ash management plan be developed and a chemical prevention treatment plan be put into place to protect high value ash trees. We also recommend the release of biological control agents if it does not conflict with the Park's management plan.

Purpose and Need

In the summer of 2015, the Forest Health Protection unit of the Forest Service, Northeastern Area, State and Private Forestry Field Office (MFO) in Morgantown, WV, received a request from Kate Jensen, Ecologist and IPM Manager from Valley Forge National Historical Park (VAFO) and Hopewell Furnace National Historic Site (HOFU), and Casey Reese, Regional IPM Coordinator, Northeast Region, USDI National Park Service, to conduct a biological evaluation in regards to the rapidly approaching EAB towards the Park. We also received a letter from Kate Hammond, VAFO's and HOFU's Superintendent, supporting the importance of implementing available emerald ash borer management options in order to protect and maintain the ash resources at VAFO and HOFU.

In October 2015, Forest Health Protection personnel from MFO met with personnel from VAFO to discuss the ash (*Fraxinus* spp.) inventory being conducted over the last few months by Park personnel. Forest Health Protection personnel recommended some methods for assessing the health of the ash trees and discussed the need for management activities at the Parks.

Species Evaluation/Background

Emerald ash borer (EAB), *Agrilus planipennis* (Fairmaire), is a wood-boring beetle from Eastern Asia (Poland and McCullough 2006) that is causing severe mortality in North American ash (Tluczek et al.2011). Emerald Ash Borer affects all species and diameter classes of ash and often kills both healthy and stressed trees within 3 to 5 years of their becoming infested (Siegert 2012).

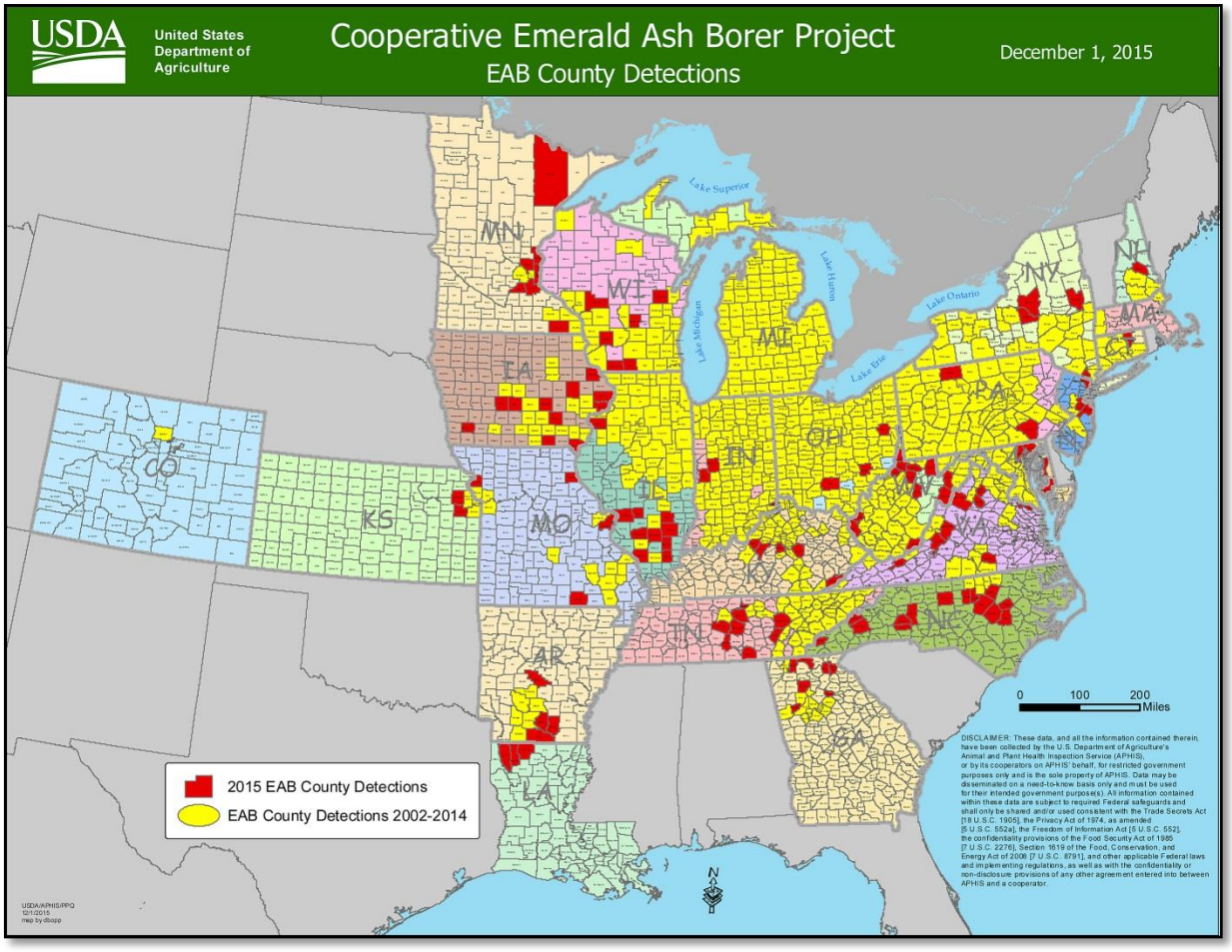
Based on data from the USDA Animal and Plant Health Inspection Service, EAB emerges around mid-June and is present through mid-August (www.emeraldashborer.info). Adult beetles are slender, elongate, and bright green, and feed on ash foliage in patches along the leaf margins (Kovacs et al. 2010). Adult beetles usually live for about 3 weeks, and females lay about 60-90

eggs (McCullough and Katovich 2004). Eggs hatch in 7-10 days, and larvae chew through the bark and feed on phloem and outer sapwood for several weeks, creating S-shaped galleries packed with frass (Bauer et al. 2004). Larvae are white to cream colored, have 10 segments, and are flattened. Larvae overwinter in shallow chambers in the outer sapwood or bark on thick-barked trees (Bauer et al. 2004). EAB pupate in late April or May, and adults emerge 1-2 weeks after pupation through D-shaped exit holes (McCullough and Katovich 2004).

In addition to causing severe economic damage, there are ecological consequences associated with the loss of ash from North American forests. Studies show that ash trees provide food and habitat for several bird and mammal species (Faanes 1984, Rumble and Gobeille 1998). Forty-three native arthropod species are at high risk due to their association with ash for breeding or feeding (Gandhi et al. 2010). Ash also contributes to nutrient cycling in hardwood forests (Reiners and Reiners 1970).

EAB was first found in the Detroit, Michigan/Windsor, Ontario area in 2002. To date, EAB has been detected in 25 states including: Michigan, Arkansas, Colorado, Connecticut, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Minnesota, Missouri, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, Wisconsin, as well as Canadian provinces of Ontario and Quebec (Figure 1).

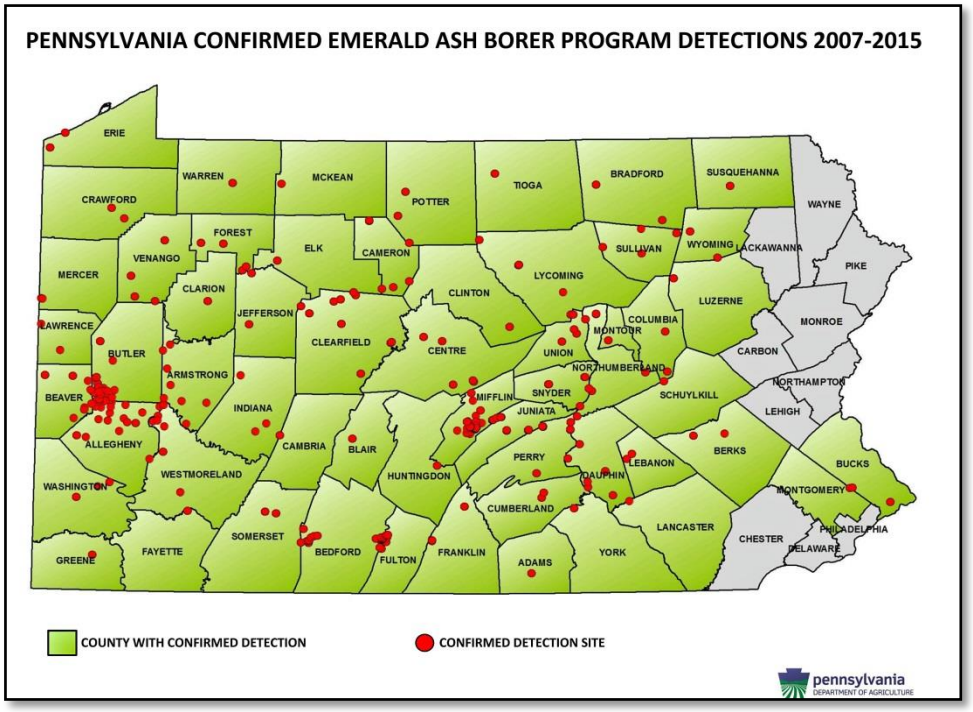
Figure 1. *Emerald ash borer county detections as of December 1, 2015 (USDA APHIS PPQ 2015).*


USDA
United States Department of Agriculture
Cooperative Emerald Ash Borer Project
EAB County Detections
December 1, 2015
Lake Superior
Lake Michigan
Lake Huron
Lake Erie
Lake Ontario
MN
WI
MI
NY
NH
MA
CT
PA
IA
IL
IN
OH
WV
VA
MD
NJ
DE
KY
TN
NC
SC
GA
AR
LA
MS
AL
MO
KS
CO
0 100 200 Miles
2015 EAB County Detections
EAB County Detections 2002-2014
DISCLAIMER: These data, and all the information contained therein, have been collected by the U.S. Department of Agriculture's Animal and Plant Health Inspection Service (APHIS), or by its cooperators on APHIS' behalf, for restricted government purposes only and is the sole property of APHIS. Data may be disseminated on a need-to-know basis only and must be used for their intended government purpose(s). All information contained within these data are subject to required Federal safeguards and shall only be shared and/or used consistent with the Trade Secrets Act [18 U.S.C. 1905], the Privacy Act of 1974, as amended [5 U.S.C. 552a], the Freedom of Information Act [5 U.S.C. 552], the confidentiality provisions of the Food Security Act of 1985 [7 U.S.C. 2276], Section 1619 of the Food, Conservation, and Energy Act of 2008 [7 U.S.C. 8791], and other applicable Federal laws and implementing regulations, as well as with the confidentiality or non-disclosure provisions of any other agreement entered into between APHIS and a cooperator.
USDA/APHIS/PPQ
12/1/2015
map by dlopp

Emerald ash borer was first detected in Butler and Allegheny Counties, Pennsylvania in 2007. As of November 2015, EAB has been detected in all counties in PA, except for Wayne, Lackawanna, Pike, Monroe, Carbon, Northampton, Lehigh, Philadelphia, Chester, and Delaware Counties.

Emerald ash borer has been detected in Montgomery County, about 16 miles from VAFO, and in Berks County, about 25 miles from HOFU.

***Figure 2**. Pennsylvania confirmed EAB Program detections, 2007-2015 (PA Department of Agriculture).*



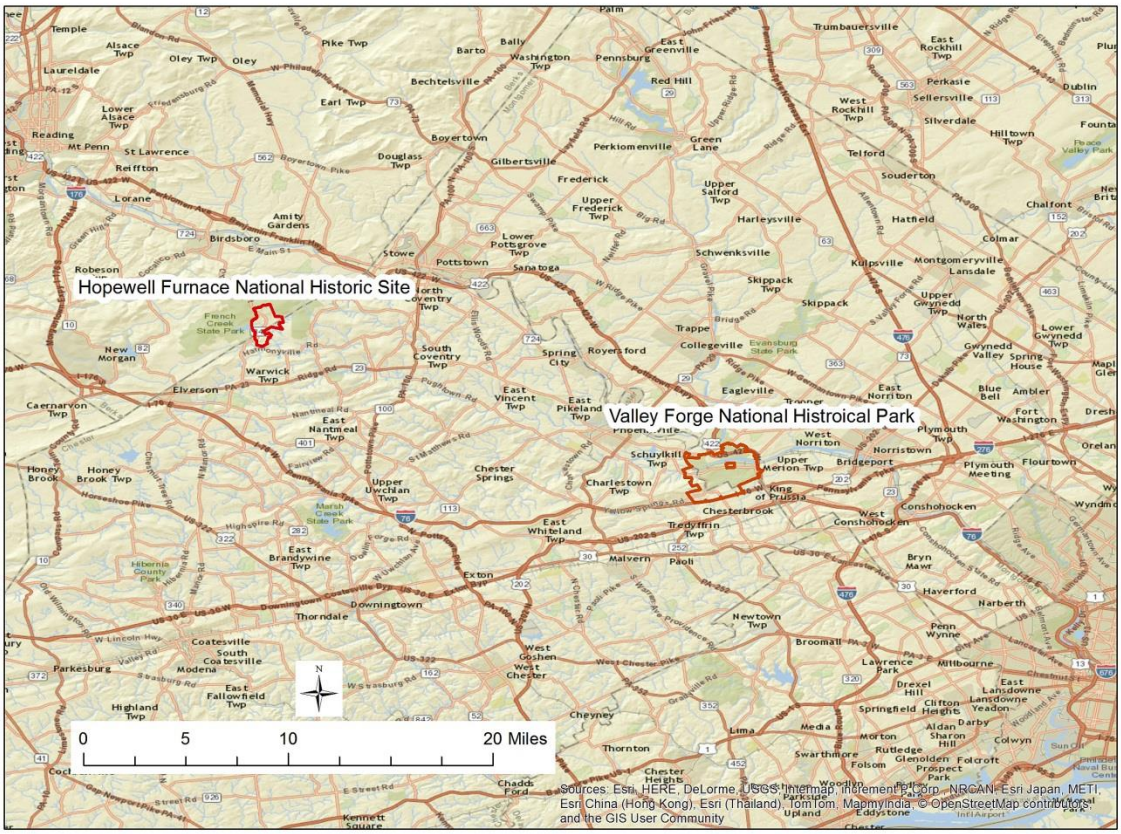
Project Location/Description/History

Valley Forge National Historical Park is a 3,452 acre park located in southeastern Pennsylvania, 20 miles northwest of center city Philadelphia. The park preserves the site of the 1777-78 winter encampment of General George Washington's Continental Army and many significant natural and cultural resources, including cultural landscapes, historic buildings and structures, archeological sites, and archives and collections. As suburban sprawl increasingly covers the land around Valley Forge, the park also increases in value as a regional bio-refuge for plants and animals (NPS 2015).

Hopewell Furnace National Historic Site is an 848 acre park located 20 miles west of VAFO. HOFU is significant for its association with more than100 years of ironmaking and its subsequent association with the preservation and development of the historic village and other

recreation facilities by the CCC and the NPS. The period of significance for the iron era reflects the entire period of production from its beginnings in 1770 to the last blast in 1883. HOFU is in the middle of the Hopewell Big Woods (HBW), the largest unbroken forest in southeastern Pennsylvania, comprising 73,000 acres of federal, state, local and private lands. HBW is managed by the Hopewell Big Woods partnership, a partnership of federal, state, township, and non-profit entities (NPS 2015).

Figure 3*. General location map of Valley Forge National Historical Park and Hopewell Furnace National Historic Site. Map provided by USDA, FS, S&PF, NA, FHP, Morgantown, WV.*


Hopewell Furnace National Historic Site
Valley Forge National Histroical Park
0
5
10
20 Miles
Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

VAFO and HOFU have varied cultural and natural resources, the parks offer interpretive programming, self-guided walking, driving, and cell-phone tours, and exhibits. Many regional visitors appreciate it as a place of recreation and renewal, with approximately 80% of visitors enjoying the park while walking, biking, boating, fishing, horseback riding, and picnicking (NPS 2015).

VAFO and HOFU recently merged under a single management structure and now share administrative, resource management, Law Enforcement, and maintenance staff (NPS 2015).

The current General Management Plan (GMP) (Valley Forge National Historical Park, 2007) defines the park's mission: "Valley Forge National Historical Park educates the American people about one of the most defining events in our nation's history and preserves the natural and cultural resources that commemorate the encampment of the Continental Army at Valley Forge in 1777-78." Supporting over 1,000 species of flora and fauna, habitats within the park include oak/tulip forests, tall grass meadows, wetlands, and riparian buffers. The GMP states: "Biological resources will be managed to restore and preserve natural diversity and abundance in a manner that would accelerate natural recovery of impacted resources." (NPS 2015).

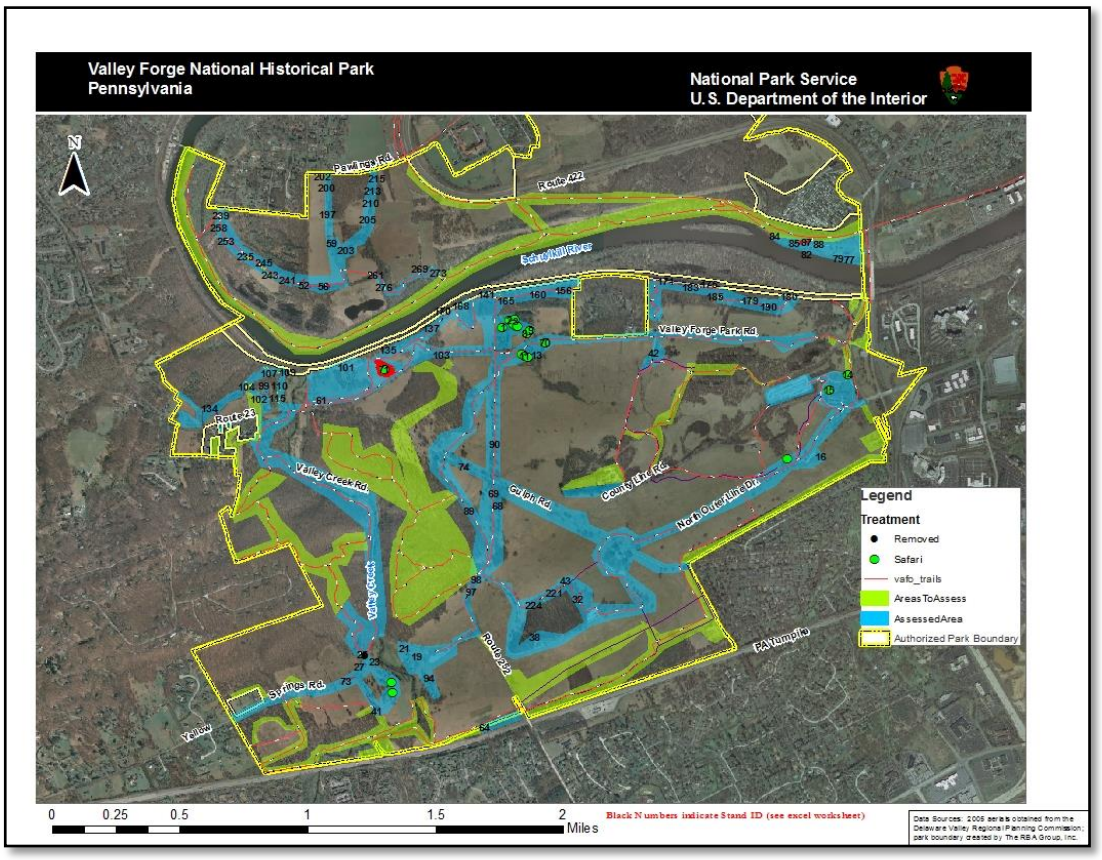
Native ash trees, up to 76 inches diameter at breast height, are an important component of the cultural landscape and historic fabric. For example, a grove of over 30 ash trees are adjacent to Washington's Headquarters, the historical focal point of the park. The ash trees in this location average 29 inches dbh. Park-wide, ash trees contribute ecologically as shade, seed source, and nesting areas. As the park recovers from a reduction from a historic high of 241 deer per square mile to a current density of 35 deer per square mile, seed production of native trees is important for forest recovery. The large ash protected by this project will contribute to this forest regeneration and to recovery of ash in areas that may not be treated. If the EAB population crashes in the future or if other treatments (such as biological controls) allow for some ash survival, there may be opportunities for reseeding of ash. Protected trees will contribute to this reseeding (NPS 2015).

Native ash trees, at least 8 over 20 inches diameter at breast height, are an important component of the cultural landscape and historic fabric at HOFU. Of the 38 trees mapped so far, 36 are within the viewshed of the historic village at HOFU. The ash trees also contribute ecologically to shade, seed source, and nesting areas, and to ash recovery in areas that may not be treated (NPS 2015).

The Integrated Pest Management (IPM) Plan for both parks was completed in 2014, and lists EAB as one of the highest priorities for prevention and treatment. The IPM Plan states it is important that both Parks be proactive, and describes prevention as equally important as response. In the IPM, it states that the ash density will be mapped in both parks to determine which trees will be treated for EAB prior to the time that the pest arrives in the Parks. Plans will be made to plant other native shrubs and trees and monitored for invasive plants in areas of high ash density that cannot be saved. The IPM Coordinator and the Maintenance staff will work together to identify and remove trees as needed. The IPM Plan states that a separate EAB Management Plan will be developed for both Parks (NPS 2015).

To date, VAFO has treated 75 of their high priority trees with Safari SG pesticide, and no trees at HOFU. Priorities include trees that have high historical value, and healthy trees with high ecological value (for example, healthy trees that produce greater than average seed). VAFO and HOFU staff are proactively identifying ash trees that would become hazards if dead (e.g. near roads, trails, parking lots, buildings) as well as identifying those trees that are significant to the natural and cultural landscape (Figure 4) (NPS 2015).

Figure 4*. Valley Forge National Historical Park, ash survey locations. Map provided by VAFO.*



Project Objectives

The objectives for this evaluation were to 1) determine whether or not EAB was present at the Parks, 2) assess the location and health of the ash, and 3) determine the need for chemical treatments to protect and maintain the ash resources.

Project Methods

Park staff are proactively identifying ash trees that would become hazards if dead (e.g. near roads, trails, parking lots, buildings) as well as identifying those trees that are significant to the natural and cultural landscape; and then determine which of these trees will be treated to prevent EAB infestation and which will be observed and removed upon becoming a hazard.

The Forest Health Protection personnel recommended some methods for assessing the health of the ash trees and discussed the importance in using this type of data to make management decisions at the Parks. The Parks are already collecting information such as the diameter breast high (DBH), making notes of noticeable defects of the tree (e.g. decay, broken branches,

cavities) and visually inspecting for signs and symptoms of EAB (e.g. excessive woodpecker activity, D-shaped exit holes, serpentine galleries). The Forest Health Protection personnel suggested the Parks also collect the crown condition rating (dieback categories- recorded in 5% intervals), which can further help in making treatment decisions.

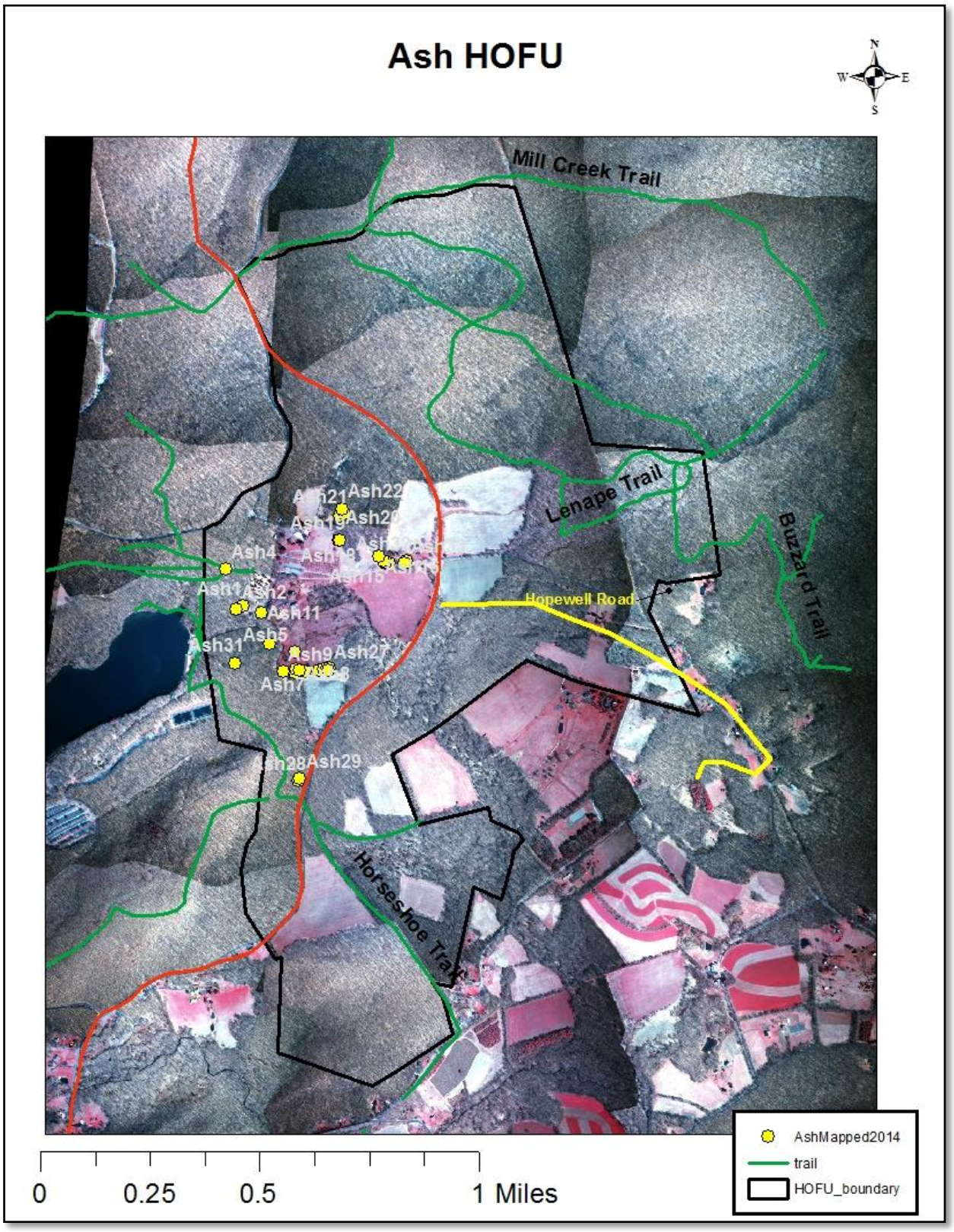
Results

No EAB were detected at the time of this report. About half of the areas of high priority (where dead trees would become a hazard) have been mapped (about 580 acres at VAFO and 50 acres at HOFU). Mapping will continue (about 500 acres at VAFO and 170 acres at HOFU).

Shown in Figure 5 and 6, are the locations of the survey areas at each park.

Figure 5. *Valley Forge National Historical Park, ash survey tree locations. Map provided by VAFO.*

Figure 6. *Hopewell Furnace National Historic Site, ash survey tree locations. Map provided by VAFO.*



Discussion

The main objectives of this evaluation were to determine whether EAB was present, inventory the area, and evaluate the need for EAB management activities. No EAB were detected at the time of the survey. Even though EAB has not been detected on site, it does not mean it is not present. A newly infested tree does not display many symptoms of attack in the first years of colonization; therefore a monitoring program should be implemented.

The basic guideline used to determine when to treat for EAB is when areas are within a quarantined county or within 10-15 miles of a known EAB infestation (Herms et al. 2014). Since emerald ash borer has been detected in Montgomery County, about 16 miles from VAFO, and in Berks County, about 25 miles from HOFU, we recommend that a comprehensive ash/forest management plan be developed that includes preemptive ash removal (e.g. removal of ash with poor form or defects that will eventually pose a hazard); chemical treatments; biological control releases; and replanting to ensure the preservation of the resource.

It can be difficult in finding a balance between tree removal and treatment. An ideal world would be to treat all ash trees; however treatment is labor intensive and it may not be fiscally possible to keep retreating all trees every 1-3 years, depending on the pesticide selection and local EAB densities.

Since individual tree treatments in the other woodlots or forest stands are not feasible, then the following approach may be implemented: select at least 10 good specimen trees (e.g. dominate, healthy, good seed producers) at a sex ratio of at least 5:1 (females:males) and treat every 1-3 years, depending on the pesticide selection and local EAB densities (Liu and Miller 2014). This is a suggestion, the Parks may choose a different sex ratio that they feel better fits their sites.

An accepted ash tree treatment requirement is that the crown dieback be 30% or less, while also taking into consideration of any other defects such as decay or poor form. Sometimes 31-60 % crown dieback may be used if the tree has been designated as treatable by using other characterizations (e.g. very high value, location) and knowing the tree will never replace the lost crown. Any tree with greater than 50% dieback cannot be expected to survive even after treatment (Herms et al. 2014).

When ash trees die, they rapidly become brittle and are more prone to snap, becoming very dangerous to remove. In some cases, treating for the remaining life of a tree may not cost any more than the cost of the up-front removal, especially if the removal is too costly or too dangerous to the remover (Liu and Miller 2014). EAB kills both healthy and stressed trees within 3 to 5 years of their becoming infested (Siegert 2012). The Park may want to develop an ash tree removal plan to help with these issues and to stagger the cost of tree removal over the years.

Any forest understory re-plantings will require protection from herbivores, such as deer and rodents, and invasive plant species competition, until the new plantings are well established. In some areas of EAB infestations, a small number of ash trees have been observed to be surviving EAB infestation (known as lingering ash). These trees, if they do survive over the long

term, may have some natural resistance to EAB and could provide the genetic material for the next generation of ash trees.

Management Options

No Action Option:
In this option emerald ash borer is allowed to infest susceptible ash trees within the Parks. Should this option be selected, it is likely that all susceptible ash trees would be attacked and die as a result of EAB. This would result in the loss of not only high value trees but native woodland trees which would result in hazard trees in public areas, and a reduction in overstory canopy

Intervention Options:
-Chemical Insecticide Option
Herms and others (2014) reviewed chemical control options for EAB, which include noninvasive systemic basal trunk sprays, soil-applied systemic insecticides, trunk-injected systemic insecticides, and protective cover sprays.

- Dinotefuran (Safari®) is labeled for controlling EAB and has shown variable results. It is sprayed on the lower 5 or 6 feet of trunk.
- Soil injection of imidacloprid has shown variable results and requires careful attention to soil conditions and tree d.b.h. Soil injections should be applied 2-4 inches below the soil surface to stay available to feeder roots, the soil should be moist to facilitate uptake, and for trees larger than 15 inches d.b.h chemical amounts should be applied at the highest labeled rate or combined with other treatment methods.
- Trunk injection of emamectin benzoate in mid-May or early June provides the most consistent control of EAB, according to test trials at Michigan State and Ohio State Universities. This was the only treatment that provided multiple years of protection (up to 3 years).
- Protective cover sprays have been shown to prevent EAB from entering trees in Michigan State University studies, but have no effect on larvae feeding under the bark. Spraying the entire tree is most effective, but there is considerable drift associated with this process.
- A natural product, azadirachtin, is also available formulated as TreeAzin™, which has the potential for systemic control of EAB. This product is a natural tetranortriterpenoid compound extracted from the seed kernels of neem (*Azadirachta indica*) (Fares et al. 1980) and is injected into the trunk of the tree.

-Biological Control Option
Currently, three parasitoid wasps, including two gregarious larval endoparasitoid species (*Spathius agrili* and *Tetrastichus planipennisi*) and a solitary parthenogenic egg parasitoid (*Oobius agrili*) are available for release against EAB through the USDA APHIS EAB Biological Control Program. Guidelines have been prepared on site selection, and methods for release and

recovery (USDA-APHIS/ARS/FS 2012). The release and establishment of EAB natural enemies is not likely to provide any short-term control of EAB. This long-term approach is still experimental and will likely require a complex of natural enemies to maintain EAB below damaging levels. It may be years before these parasites can perpetuate themselves sufficiently before any level of success can be determined.

Management Alternatives

For 2016, two options have been evaluated for managing EAB at VAFO and HOFU. The intervention options are offered based on the following objectives: 1) protect high-value ash trees and 2) protect native woodland ash trees. Each option is discussed below. With the previously described options in mind, the following alternatives are offered.

Alternatives

Alternative 1.	No action.
Alternative 2.	Select ash trees for treatment with < 30 percent decline; remove ash trees with > 30 percent decline unless the tree has been designated as treatable using other characterizations (e.g. high value, location), knowing the tree will never replace the already lost crown; and release biological control agents if it does not conflict with the Parks management plan.

Recommendations

We recommend that VAFO and HOFU Staff develop a comprehensive ash/forest management plan and put a chemical suppression/prevention treatment plan into place as soon as possible. In addition, we recommend that VAFO and HOFU begin a public awareness campaign about EAB and continue to annually monitor tree health conditions and survey for signs and symptoms of EAB infestations. In addition to visual surveys, it is also recommended to deploy attractant-baited traps to survey for low levels infestations of EAB. The MFO can assist on preparing a monitoring plan for using the traps (e.g. quantity, trap type, trap locations, etc.), and can help by preparing a display to place in their visitor center that explains their EAB management plan.

We recommend Alternative 2 based on the following considerations:

1) This alternative protects high-value ash trees and retains both large and smaller specimen trees.
2) We also recommend releasing available EAB parasitoids in infested areas that are not in proximity to chemical treatments, if this does not conflict with the Parks management plan. The establishment of these natural enemies is experimental, but may offer the opportunity for long-term control and may minimize the need for repeated chemical treatments in future years.

References

Bauer, L.S.; Haack, R.A.; Miller, D.L.; Petrice, T.R.; Liu, H. 2004. Emerald ash borer life cycle. In: Mastro, Victor; Reardon, Richard, comps. Emerald ash borer research and technology development meeting. FHTET–2004–02. Morgantown, WV: U.S. Forest Service, Forest Health Technology Enterprise Team: 8.

Faanes, C.A. 1984. Wooded islands in a sea of prairie – these isolated woodlands are important breeding habitat for northern prairie birds. American Birds. 38(1): 3–6.

Fares, Y.; Sharpe, P.J.H.; Magnuson, C. E. 1980. Pheromone dispersion in forests. Journal of Theoretical Biology. 84(2): 335–359.

Gandhi, K.J.K.; Cognato, A.I.; Lightle, D.M.; Mosley, B.J.; Nielsen, D.G.; Herms, D.A. 2010. Species composition, seasonal activity, and semiochemical response of native and exotic bark and Ambrosia beetles (Coleoptera: Curculionidae: Scolytinae) in northeastern Ohio. Journal of Economic Entomology. 103(4): 1187–1195.

Herms, D.A.; McCullough, D.G.; Smitley, D.R.; Sadof, C.S.; Cranshaw, W. 2014. Insecticide options for protecting ash trees from emerald ash borer. North Central IPM Center Bulletin. 2nd Edition. 16 p.

Kovacs, K.F.; Haight, R.G.; McCullough, D.G.; Mercader, R.J.; Siegert, N.W.; Liebhold, A.M. 2010. Cost of potential emerald ash borer damage in U.S. communities, 2009–2019. Ecological Economics. 69(3): 569–578.

Liu, H and Miller, S. 2014. Ash Management in State Forest Lands Under Pressure from the Emerald Ash Borer. Pennsylvania Department of Conservation and Natural Resources. Availablefromhttps://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20029768.pdf. 36p.

McCullough, D.G.; Katovich, S.A. 2004. Pest Alert: emerald ash borer. NA–PR–02–04. U.S. Department of Agriculture, Forest Service, Northeastern Area State and Private Forestry. 2 p.

Poland, T.M.; McCullough, D.G. 2006. Emerald ash borer: invasion of the urban forest and the threat to North America's ash resource. Journal of Forestry. 104(3): 118–124.

Reiners, W.A.; Reiners, N.M. 1970. Energy and nutrient dynamics of forest floors in three Minnesota forests. Journal of Ecology. 58(2): 497–519.

Rumble, M.A.; Gobeille, J.E. 1998. Bird community relationships to succession in green ash (*Fraxinus pennsylvanica*) woodlands. American Midland Naturalist. 140: 372–381.

Siegert, Nathan W. 2012. Emerald Ash Borer: Biology, Impacts and Options. Tree Care Industry Magazine. 22(8): 8-15.

Tluczek, A.R.; McCullough, D.G.; Poland, T.M. 2011. Influence of host stress on emerald ash borer (Coleoptera: Buprestidae) adult density, development, and distribution in *Fraxinus pennsylvanica* trees. Environmental Entomology. 40(2): 357–366.

USDA APHIS PPQ. 2015. Emerald Ash Borer County Detection Map for October 1, 2015. https://www.aphis.usda.gov/plant_health/plant_pest_info/emerald_ash_b/downloads/NewCountyDetectionMap2015.pdf

USDA APHIS/ARS/FS. 2012. Emerald Ash Borer, *Agrilus planipennis* (Fairmaire), Biological Control Release and Recovery Guidelines. USDA-APHIS-ARS-FS, Riverdale, Maryland. 37p.

U.S. Department of Interior, National Park Service. 2007. Valley Forge National Historical Park General Management Plan. USDI NPS Valley Forge National Historical Park, Valley Forge, PA. 1-8p.

U.S. Department of Interior, National Park Service. 2014. Integrated Pest Management Plan for Valley Forge National Historical Park and Hopewell Furnace National Historic Site. USDI NPS Valley Forge National Historical Park, Valley Forge, PA. 123p.

U.S.Department of Interior, National Park Service. 2015. Treatment of high-priority ash trees to prevent infestation by emerald ash borer at Valley Forge National Historic Park and Hopewell Furnace National Historic Site. USDA Forest Service, Forest Health Protection, Federal Lands Project Proposal, FS-3400-2.